tained, by the hourly averages for March 18–24, the week of the vernal equinox, for April 22–28, the first week on which radiation was recorded at midnight, for June 17–23, the week of the summer solstice, and finally a curve representing the maximum average hourly intensities recorded in each of the 24 hours. The sum of these last-named hourly averages multiplied by 60 gives the maximum daily radiation with clear skies for the year.

It is to be noted that the average daily amount for the three weeks centering on the summer solstice is greater than the average of the daily normals for this period for any stations in the United States except Twin Falls, Idaho, and Fresno, Calif., as given in Table 4, MONTHLY WEATHER REVIEW for February, 1930, volume 58, page 45.

What must be the effect upon plant and animal life of this stimulus of continuous solar radiant energy during four months of the year? In lower latitudes it has been found that generally plants as well as animals require the night hours of rest for their best development.

SOLAR RADIATION MEASUREMENTS MADE AT MOUNT EVANS, GREENLAND

These measurements were made by C. R. Kallquist and Prof. J. E. Church, jr., members of the University of Michigan Greenland Expedition, between August 13, 1927, and April 17, 1928, which covers a part of the period during which measurements of solar radiation were made at Green Harbor, Spitzbergen. The instrument employed was of the Moll type of thermoelectric pyrheliometer, mounted in a diaphragmed tube, with attachments that enabled the observer to keep the instrument accurately pointed on the sun. The current generated by the heating effect of solar radiation on the free junction of the pile was determined by an eye reading on a Weston millivoltmeter. The pyrheliometer was carefully standardized at the United States Weather Bureau before the departure of the expedition, to determine the e. m. f. developed in the pile by solar radiation of known intensity. It was hoped to recalibrate the instrument after its return from Greenland. Unfortunately, however, while the pyrheliometer was received back in excellent condition the millivoltmeter was ruined by the upsetting of a boat in which it was being transported. A satisfactory recalibration of the complete apparatus was therefore impossible.

A brief summary of these measurements was given by me in a paper in the Review for February, 1930.[4] They are here summarized in more detail.

TABLE 2.—*Pyrheliometric readings made by Prof. J. E. Church, jr., during trip to and on inland ice. Direction of travel, east from latitude 66° 50′ N., longitude 51° W., total distance, 30 miles*

[Gram-calories per minute per square centimeter of normal surface]

Date	Air mass									
	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5
1927	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*
Aug. 13, a. m.	1.48	1.32	1.20							
Aug. 13, p. m.		1.33	1.23	1.15	1.07	1.00	0.94	0.88	0.84	0.80
Aug. 14, a. m.	1.44	1.35	1.26							
Aug. 14, p. m.		1.33	1.24	1.16	1.08	1.02	0.96	0.91	0.86	0.81
Aug. 15, a. m.	1.45	1.33	1.23	1.16	1.09	1.03				
Aug. 15, p. m.		1.33	1.23	1.12	1.08	0.95	0.89	0.86	0.84	0.82
Aug. 16, a. m.	1.30	1.22	1.16	1.09	1.02	0.96	0.91			
Aug. 16, p. m.			1.16	1.10						
Aug. 17, a. m.	1.40	1.32	1.25	1.18	1.12	1.07	1.04	1.01	0.98	0.97
Aug. 17, p. m.		1.34	1.21	1.10						
Aug. 20, a. m.	1.38	1.29	1.20	1.14	1.08	1.04	1.00	0.96		
Means	**1.40**	**1.32**	**1.22**	**1.13**	**1.07**	**1.01**	**0.96**	**0.92**	**0.88**	**0.85**

[4] Kimball, Herbert H. Measurements of solar radiation intensity and determinations of its depletion by the atmosphere. Monthly Weather Review. 58:43.

Table 2 summarizes measurements made by Professor Church, between August 13 and 16, inclusive, on the journey from the shore to the inland ice, at altitude of from 250 to 450 feet above sea level; on August 17 at the edge of the ice where the altitude was about 950 feet and on August 20 on the inland ice, at an altitude of between 1,600 and 1,800 feet. The distance covered was about 30 miles, and the direction traveled was approximately east, so that there was little change in latitude. The change of correction necessary to reduce forty-fifth meridian time to apparent time was taken into account in computing solar altitudes corresponding to the time at which the measurements were made. Solar altitudes at noon varied from 37° 45′ on August 13 to 35° 32′ on August 20, corresponding to air masses 1.63 and 1.72, respectively. The intensities for air mass 1.5 and 1.0 were therefore obtained by extrapolation.

Table 3 summarizes measurements made by C. R. Kallquist at Mount Evans, Greenland, on the inland ice, at an altitude of 1,228 feet (374 meters). Slight extrapolations have in a few cases been necessary to obtain the intensities tabulated. In general, the readings indicate a very pure and dry atmosphere, as is shown by the values for the atmospheric transmission given in Table 4.

TABLE 3.—*Pyrheliometric readings made by C. R. Kallquist at Mount Evans, Greenland. Latitude 66° 51′ N., longitude 50° 50′ W., altitude 1,228 feet*

[Gram-calories per minute per square centimeter of normal surface]

Date	Solar altitude												Vapor pressure
	30.0°	23.5°	19.3°	16.4°	14.3°	11.3°	9.3°	7.8°	6.8°	3.1°	1.8°	0.7°	
	Air mass												
	2.0	2.5	3.0	3.5	4.0	5.0	6.0	7.0	8.0	15.0	21.0	30.0	
1927	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*mm.*
Sept. 6, p. m.	1.32	1.26	1.20										4.75
Sept. 7, p. m.	1.31	1.26											4.37
Sept. 17, p. m.		1.34	1.25	1.19	1.15	1.08	1.01			0.42			
Sept. 18, p. m.		1.30	1.24	1.19	1.14	1.07	1.02				0.62		
Sept. 20, p. m.		1.40	1.23	1.22						0.65			2.74
Sept. 22, p. m.				1.18	1.14	1.08							
Sept. 24, p. m.		1.31	1.25	1.20									2.62
Sept. 25, p. m.			1.30	1.22	1.18	1.11							2.74
Means	**1.32**	**1.31**	**1.25**	**1.20**	**1.15**	**1.08**	**1.02**			**0.54**	**0.62**		**3.44**
Oct. 12, a. m.				1.28	1.21	1.10	1.03						2.16
Oct. 12, p. m.				1.22	1.16	1.06							
Means				1.25	1.18	1.08	1.03						
1928													
Feb. 18, p. m.						1.25	1.14	1.10	1.09	0.76		0.27	0.38
Mar. 20, a. m.		1.47	1.39	1.34	1.30								0.51
Mar. 20, p. m.		1.56	1.39		1.32	1.18	1.07						
Means		**1.52**	**1.39**	**1.34**	**1.31**	**1.18**	**1.07**						
Apr. 3, a. m.	1.47	1.38	1.30	1.22									1.52
Apr. 3, p. m.	1.50	1.38	1.29	1.24	1.19								
Apr. 4, a. m.	1.44	1.40	1.33	1.28									0.58
Apr. 4, p. m.		1.35	1.25	1.15	1.06								
Apr. 17, a. m.	1.38												2.74
Apr. 17, p. m.	1.34	1.28	1.22	1.18	1.12	1.03	0.94	0.86					
Means	**1.43**	**1.36**	**1.28**	**1.21**	**1.12**	**1.03**	**0.94**	**0.86**					**1.61**

TABLE 4.—*Atmospheric transmission for solar radiation*

Date	Solar altitude	Air mass		Intensity	Vapor pressure	Precipitable water	Atmospheric transmission		Difference
		m	$m\frac{P}{760}$	I			I/I_s	Computed	
1928	°			*Gr. cal. min. cm.²*	*Millimeters*	*Centimeters*			
Mar. 20	14.3	4.0	3.80	1.31	0.51	0.11	0.675	0.705	0.030
Do	19.3	3.0	2.85	1.39	0.51	0.11	0.716	0.752	0.036
Apr. 17	30.0	2.0	1.90	1.36	2.74	0.605	0.707	0.746	0.039
Sept. 6-7	30.0	2.0	1.90	1.31	4.57	1.00	0.693	0.721	0.028

In this table m is the value of the length of the path of the solar rays in passing through the atmosphere in terms of the length when the sun is in the zenith, as computed by Bemporad. In the following column m is multiplied by the ratio of the atmospheric pressure to standard pressure, or 760 mm. I is the measured intensity of solar radiation, and $I_R{}^2$ is the mean value of the solar constant, I_0 divided by the square of the earth's radius vector in terms of its mean value. The computed atmospheric transmission is obtained from the MONTHLY WEATHER REVIEW, February, 1930, volume 58, page 52, Figure 1. The atmospheric depletion indicated by this computed transmission includes all that Fowle found correlated with pure dry air and water vapor. The difference between the two transmission values must be attributed to depletion by impurities in the atmosphere.

Comparing these differences with corresponding differences for Washington, D. C.; Madison, Wis.; Lincoln, Nebr.; and Davos, Switzerland, given on page 51 of the REVIEW cited above, it is seen that the atmosphere at Mount Evans, Greenland, is relatively free from dust at all seasons of the year, as we would expect it to be.

RAIN-GAGE FUNNELS OF DIFFERENT DEPTHS

By JOHN GLASSPOOLE, M. Sc., Ph. D.

[Meteorological Office, London]

With reference to the article on "Rainfall catch as affected by different depths of funnels in the rain gage,"[1] it may be of interest to refer to some of the experiments which have resulted in the adoption of the deep-funnel gage as the standard pattern in the British Isles.

At the majority of the official stations of the Meteorological Office the 8-inch gage is used, in continuation of a practice which dates back to about 1870. According to the current specification the funnel has vertical walls 5¾ inches deep. By far the greater number of gages in use in the British Isles are, however, 5 inches in diameter. In the case of the standard "Snowdon" gage the diameter is 5 inches and the depth of the vertical walls is about 4 inches. In the Meteorological Office version of this gage the depth of the vertical walls is 4¹¹⁄₁₆ inches and the funnel proper slopes at 33½° to the horizontal. The rain is collected in a bottle holding about 3½ inches, standing in a copper can, the total capacity of which is about 9 inches. The inner can stands in an outer can, on to the top of which the funnel fits. The base of the outer can is splayed so that the gage can be fixed firmly in the ground at such a depth that the rim is exactly 1 foot above the surface. Somewhat similar gages, but of larger capacity are used for monthly measurements. In these gages a dip rod is used, but only for the purpose of giving a rough check reading. The actual measurement is made by pouring the water into a cylindrical glass measure graduated in inches and tenths. For daily observations, measuring glasses with taper bases are used. These glasses are subdivided to 0.01 inch or 0.1 mm., the former have an additional graduation at 0.005 inch for the purpose of making it easy to decide whether a small amount is to be counted as a "trace" or as 0.01 inch. This is important because in the latter case the day ranks as a rain day. These particulars are given in some detail because it is important, in this connection, to remember that the instruments used in the British Isles are very different from those used in America.

According to Mr. R. H. Scott, a former head of the Meteorological Office, the deep-funnel gage was invented by Quetelet. A gage with a vertical wall of 6.3 inches is described in "Sur le Climat de la Belgique, cinquieme partie" by Quetelet, published in 1852. The introduction of the deep-funnel gage in the British Isles was due mainly to Mr. G. J. Symons, the founder of the British Rainfall Organization, now incorporated in the Meteorological Office. It was first used about 1864, and subsequently on Mount Snowdon. It became known as the Snowdon pattern, and has gradually replaced gages of the British Association and Howard patterns, which have shallow funnels. Even at the present time, however, some 1,500 of the 5,000 voluntary observers in the British Isles use a gage of nonstandard pattern, of which the vertical walls above the funnel are usually less than half an inch in depth.

It must be admitted at the outset that in the normal conditions prevailing in the British Isles, the use of a deep-funnel gage makes no great difference to the measured annual total. It is not possible by a critical comparison of the monthly or annual records in a given locality to detect the returns from shallow-funnel gages. This generalization is supported by the records from stations which have gages of both patterns. Three typical cases are quoted below:

Station	County	Period of observation	Mean annual values			
			Shallow funnel	Snowdon funnel	Difference	
			Inches	*Inches*	*Inches*	*Per cent*
Tenterden	Kent	1876–1921	28.28	27.76	+0.52	+1.9
Swinton House	Berwick	1914–1921	26.16	26.03	+.13	+.5
Purley	Surrey	1907–1920	31.16	31.48	−.28	−.9

The differences year by year depart little from these mean values. It should be noted, however, that if any obvious error occurred—e. g., during snow—the same amounts were generally adopted for both gages. Some observers have noted that the shallow gage gave a slightly larger number of rain days.

It has been possible, however, to attribute inconsistencies in the *daily* readings at adjacent stations to the use of a shallow-funnel gage at one or more of them. During periods of snow and of intense rain or hail, the standard gage invariably retains a better sample of the precipitation. Although there is obviously more risk of loss with the shallow-funnel gage by outsplashing from the funnel during intense rain or hail few comparative readings are on record. Even when such readings are available some doubt often exists as to whether they are strictly comparable owing to such precipitation being particularly local.

Some of the earliest experiments in the British Isles on this subject were made by Colonel Ward, at Calne (Wiltshire) during the years 1865 to 1868.[2] Colonel Ward found that during the summer six months a shallow

[1] MONTHLY WEATHER REVIEW, July, 1930, vol. 58, pp. 282–283.

[2] British Rainfall, 1874, pp. 25–34.